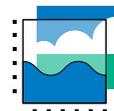




CML: Institute of Environmental Sciences



**Universiteit
Leiden**
The Netherlands



CML

Institute of Environmental Sciences

Discover the world at Leiden University.



Welcome

The Institute of Environmental Sciences (CML) is one of the leading global institutes in environmental sustainability. We are pleased to present the highlights of our work over the past year in this annual report. We hope you will enjoy it.

In 2017 we published over 70 papers, appointed two new professors, researched microplastic contamination in European beach sediment and modelled future energy demand. We awarded six PhDs and taught students from all over the world how to contribute to sustainability.

We wish you a pleasant read.
CML staff, researchers and students

CML aims to contribute to the sustainable governance of biodiversity and natural resources worldwide

Research

CML has two research departments: Conservation Biology and Industrial Ecology.

Our Conservation Biology department studies the effects of human activities on the entire biological chain, while the Industrial Ecology department develops tools for decision-making on sustainable production and consumption.

Our research is a balanced mix of fundamental and applied science for national and European science foundations, and contract research for clients such as the Dutch government and companies in the private sector.

Education

CML's courses link science to societal issues and prepare students for a role in managing the world's natural resources and biodiversity. We offer a Masters in Industrial Ecology, a Minor in Sustainable Development, a Master specialization in Biodiversity and Sustainability, a popular open online course (MOOC) on the Circular Economy, and a PhD programme. During their time at CML, students work together in multidisciplinary groups using interactive learning methods.

- ## 1978

CML was founded as part of Leiden University
- ## 2

Research departments: Conservation Biology and Industrial Ecology
- ## 5

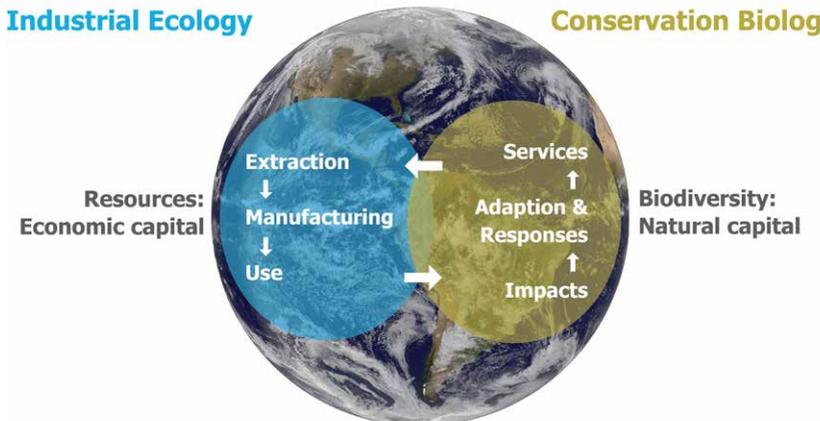
Teaching programmes
- ## 6

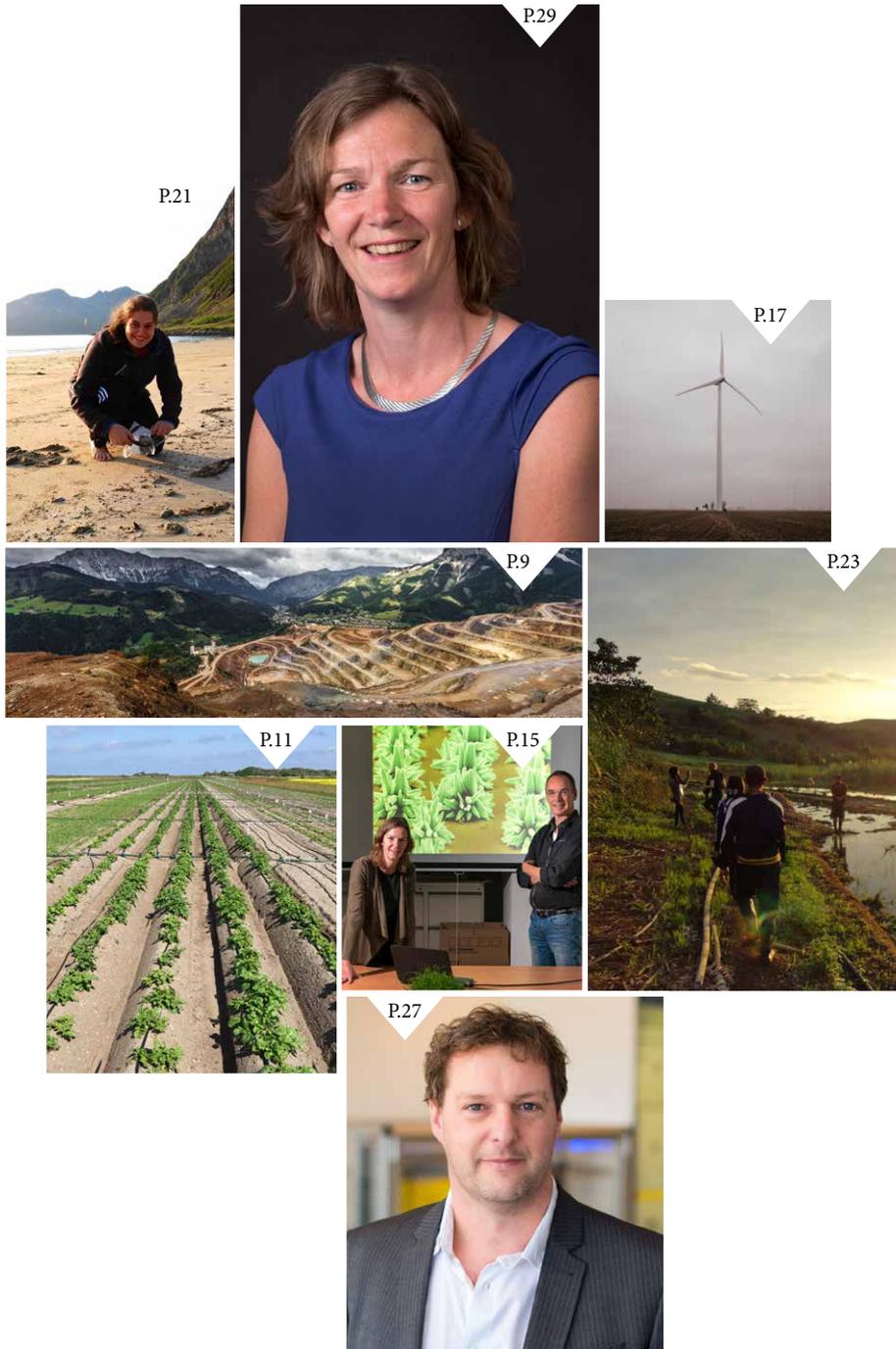
PhDs awarded in 2017
- ## 75

Publications in 2017

Industrial Ecology

Conservation Biology





Contents

Society

Investigating critical resource issues <i>Ester van der Voet continues membership of the International Resource Panel</i>	9
Salt-tolerant crops to feed the world <i>Specific vegetable varieties appear to thrive in saline conditions</i>	11

Research

Collaboration in the Nano era <i>Plea by CML researchers for early cooperation published in Nature Nanotechnology</i>	15
Metal constraints for a low-carbon economy? <i>CML researchers model use of metals up to 2050</i>	17

Education

Plastic between your toes <i>Bachelor student researches microplastic contamination in European beach sediment</i>	21
Area studies minor students <i>Minor students work on real-life sustainability challenges in Leiden, Indonesia and The Philippines</i>	23

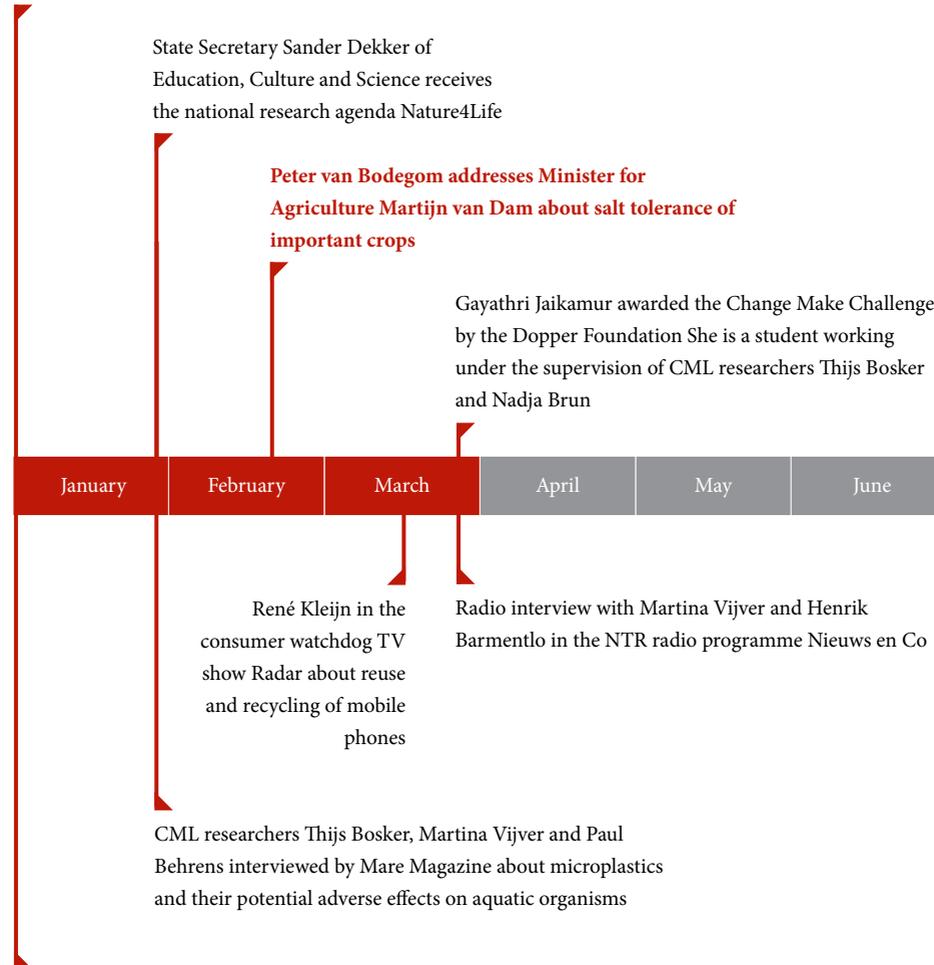
Organisation

Koos Biesmeijer appointed Professor of Natural Capital <i>He is combining his professorship with his position as Scientific Director at Naturalis</i>	27
Martina G. Vijver appointed Professor of Ecotoxicology <i>Gaining insights into chemical stressors to assess and mitigate ecosystem threats</i>	29

Society 2017

Stans Award for best outreach 2017:

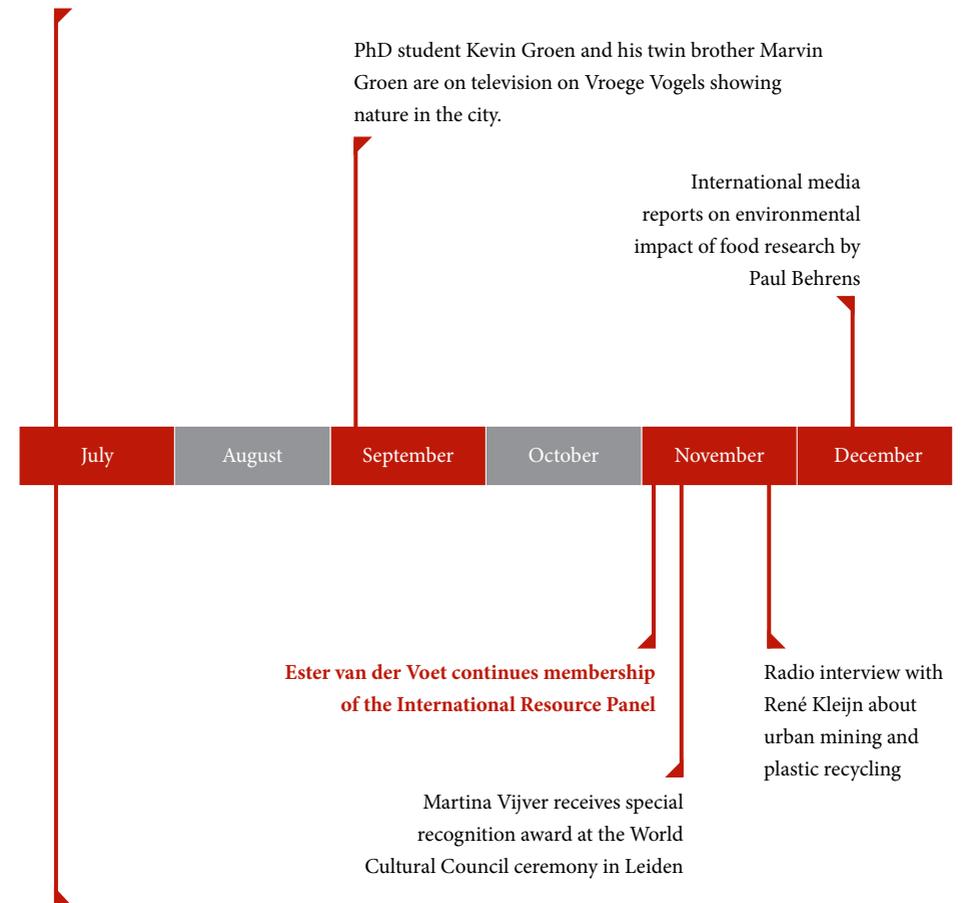
Kevin & Marvin Groen



Alexander van Oudenhoven - lead author at the Intergovernmental Platform on Biodiversity and Ecosystem Services

Two scientific papers in Science deliver new pieces of the puzzle for the reasons behind the decline in the number of bees.

Professor Koos Biesmeijer comments on this research in articles in the Dutch newspapers Volkskrant and NRC.





Investigating critical resource issues

Ester van der Voet continues membership of the International Resource Panel

With a forecast human population of 9.2 billion by 2050 accompanied by continuing world economic growth, the International Resource Panel (IRP) has the urgent task of helping to transform how we use resources. The IRP was launched by the United Nations Environment Programme (UNEP) in 2007. CML Professor Ester van der Voet has been a member of the panel since 2011 and contributed to multiple IRP reports. Her membership was renewed for the second time in 2017.

IRP investigates the world's most urgent resource issues with a view to advising not only governments, but also industry and society in a wider sense. The IRP's goal is to provide information that is needed to steer us away from overconsumption, waste and ecological harm to a more prosperous and sustainable future. Van der Voet was lead author of the report *Environmental challenges of anthropogenic metals flows and cycles* (2013) and contributed to the

reports *Green Energy Choices: The benefits, risks and trade-offs of low-carbon technologies for electricity production* (2016), *Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials* (2010), and *Resource Efficiency: Potential and Economic Implications* (2017).

Smarter use of resources

Smarter and more efficient use of the world's natural resources today means the next generation will reap annual economic benefits of \$2 trillion by 2050, while offsetting the costs of ambitious climate change action, according to the IRP report *Resource Efficiency: Potential and Economic Implications* released in 2017. Without urgent steps to increase efficiency, the global use of metals, biomass, minerals such as sand, and other materials, will increase from 85 to 186 billion tons per year by 2050. The report found that while investment in ambitious climate action would cause a 3.7 per cent fall in *per capita* Gross World Product by 2050, this cost to the economy could be offset by more efficient use of resources.

Read more about IRP:
www.resourcepanel.org

“I expect that the International Resource Panel will become more important in the coming years. The importance of resource efficiency is great and that is becoming clearer.”

Ester van der Voet, Associate Professor of Industrial Ecology



Salt-tolerant crops to feed the world

Specific vegetable varieties appear to thrive in saline conditions

Globally, 1 billion hectares of land is negatively affected by salinity and this number is increasing by 2,000 hectares every day. Salt Farm Texel and Dutch researchers, including CML Professor Peter van Bodegom, have found a way to grow certain crops on depreciated, saline agricultural land. Through a special cultivation method and by growing specific crops, huge areas of saline soil can be used worldwide to grow food: a breakthrough in food security.

Field trials were performed between 2012 and 2015 at the open-air laboratory of Salt Farm Texel in The Netherlands. Through its unique design, reliable field trials could be conducted under highly controlled conditions, irrigating crops with seven different salt concentrations, each replicated eight times. In this way it was possible to evaluate the salt tolerance of many different species and varieties.

The researchers found that several important crops are more tolerant to salt than previously assumed. Specific potato varieties, carrots, red onions, white cabbage and broccoli appear to thrive if they are irrigated in a special way at the root with salt water. This implies that, at least on sandy soils using drip irrigation, these varieties can be cultivated under moderately saline conditions without loss in yield. It also opens up possibilities for cultivation on moderately saline soils anywhere in the world.

Salt Farm Foundation

The resulting report 'Salt Tolerance Crops' was presented to the Dutch Minister for Agriculture Martijn van Dam on 22 February 2017. It was also sent to the Dutch House of Representatives. In response the Dutch government made 400,000 euros extra available to set up a knowledge centre called the Salt Farm Foundation, intended to further develop, market and transfer this special Dutch cultivation knowledge. CML participates in this knowledge centre.

Read the report:
tinyurl.com/ReportSaltTolerance

"This has important implications for our water and agricultural policies in the Netherlands and food security in saline regions across the globe, that until now were depreciated for agricultural use."

Peter van Bodegom, Professor of Environmental Biology

Research 2017

Stans Awards:

- Best scientific publication: Jeroen Guinée, Reinout Heijungs, Martina Vijver and Willie Peijnenburg
- Best Master thesis: Davide De Mauro

PhD awarded to Ishmael Kosamu for *Management of Small-Scale Fisheries at the Elephant Marsh in Malawi*

PhD awarded to Tracy Evans for *Management implications for invertebrate assemblages in the Midwest American agricultural landscape*

Best Spanish doctoral thesis in soil science in 2015 for CML researcher Daniel Arenas Lago; prize awarded in March 2017



PhD awarded to Rachmat Budiwijaya Suba for *Impact of land use changes on the human-elephant conflict*

Higher temperatures are resulting in changes to vegetation and soil in mountain areas throughout the world. An international research team including Leiden ecologist Ellen Cieraad publishes an article on 25 January in Nature on the disruption to the ecosystem.

A systematic approach to quantify the impacts of food consumption on animal welfare developed by CML researchers in collaboration with ETH Zurich. The results are published in the International Journal of Life Cycle Assessment

Article *Climate change and the vulnerability of electricity generation to water stress in the European Union* published in Nature Energy

Plea for early cooperation on environmental impacts of nanoparticles published in Nature Nanotechnology

PhD awarded to Yinlong Xiao for *Fate, accumulation and ecotoxicity of copper nanoparticles under environmentally relevant conditions*



PhD awarded to Girma Eshete Genbere for *Ecology of the Ethiopian wolf (Canis simensis Rüppell 1835) in a changing landscape*

PhD awarded to Guangchao Chen for *The use of computational toxicology in hazard assessment of engineered nanomaterials*

Article *Metal constraints for a low-carbon economy?* published in the journal Resources, Conservation, Recycling

Fluctuations in individual plant communities contribute to the stability of an ecosystem as a whole, a study published in Ecology Letters shows. Nadia Soudzilovskaia and colleagues use for the first time data from plant communities across five continents to prove this hypothesis

*For a complete list of all publications: www.cml.leiden.edu/publications



Collaboration in the Nano era

Plea by CML researchers for early cooperation published in Nature Nanotechnology

Sustainability is often seen to be the driver for new fabrics, materials and products. But is the sustainability claim really true in practice? CML researchers publish plea for early cooperation to assess the environmental impacts of nanomaterials in Nature Nanotechnology.

CML researchers Jeroen Guinée, Reinout Heijungs, Willie Peijnenburg, and Martina Vijver study the impact of new technologies and materials on the environment. Nanotechnology is one of the novel technologies that fits these criteria and is used to illustrate their scientific reasoning. The authors discussed two different methods enabling the sustainability claim for future technologies to be addressed: Risk Analysis (RA) and Life Cycle Analysis (LCA). 'With RA you study the environmental impact of one specific substance for a specific activity and moment. With LCA you study the environmental impact of a product, from the moment it is being developed until the end of its use and waste management,' Guinée explains.

Early cooperation is essential

Through early collaboration, Guinée and his colleagues hope to bridge the knowledge gap and prevent adverse impacts of nanomaterials on the environment. Early assessment of environment impacts is essential, because at this stage changes can still be made. Guinée: 'Once a product or technology is in use and a lot has been invested in the development and perhaps thousands of people find their jobs in that sector, it will not go away so easily. Even if the product or technology is not good for the environment.' Their advice to fellow researchers? 'Team up with a partner who masters the other method, either RA or LCA, and identify your common problem. Then think about what and how you can learn from each other and emphasize the necessity of both methods in your project proposal.' The perspective paper in Nature Nanotechnology introduced and opened up the debate on the role of RA and LCA in the assessment of the environmental pros and cons of nanomaterials within the scientific as well as in the regulatory community.

Read the plea for action:
tinyurl.com/PaperActionNano

'New technologies can claim to be green and clean, but you have to investigate this from the first development.'

Martina G. Vijver, Professor of Ecotoxicology



Metal constraints for a low-carbon economy?

CML researchers model use of metals up to 2050

Low-carbon energy systems are more metal-intensive than traditional energy systems. Concerns have been expressed that this may hamper the transition to a low-carbon economy. CML researchers have estimated the required extraction of iron, aluminium, copper, nickel, chromium, indium, neodymium, dysprosium, lithium, zinc and lead until 2050.

However the current amounts used in such low-carbon energy systems are relatively low compared to uses in other applications, Leiden researchers have found. Hence it is important to find out if the growth of use in such sectors will be large compared to current dominant applications. Applying Life Cycle Assessment and Input Output methods, tools pioneered by CML, scenarios were developed for the power and automotive sectors in specific and the wider economy in general.

Overall, the differences between the business as usual and low-carbon scenarios were much more moderate than thought. “In both types of scenarios, you see for most metals a demand that is 3 to 4 times higher in 2050 than now,” says Arjan de Koning, who led the study. “In the low-carbon scenario, we see only for Neodymium and Dysprosium a factor 5-8 growth in demand. At the same time, the current economic reserves for these metals are sufficient to cover their cumulative demand until 2050.”

Implications of this research

The main message of the research was that availability of the researched metals is unlikely to be a bottleneck for the transition to a low-carbon energy system. However, the combination of a lack of certainty about return on investment, long lead times in expanding mining production, and concerns about impacts of mining that are delaying the expansion of mining capacity may well create imbalances in demand and supply.

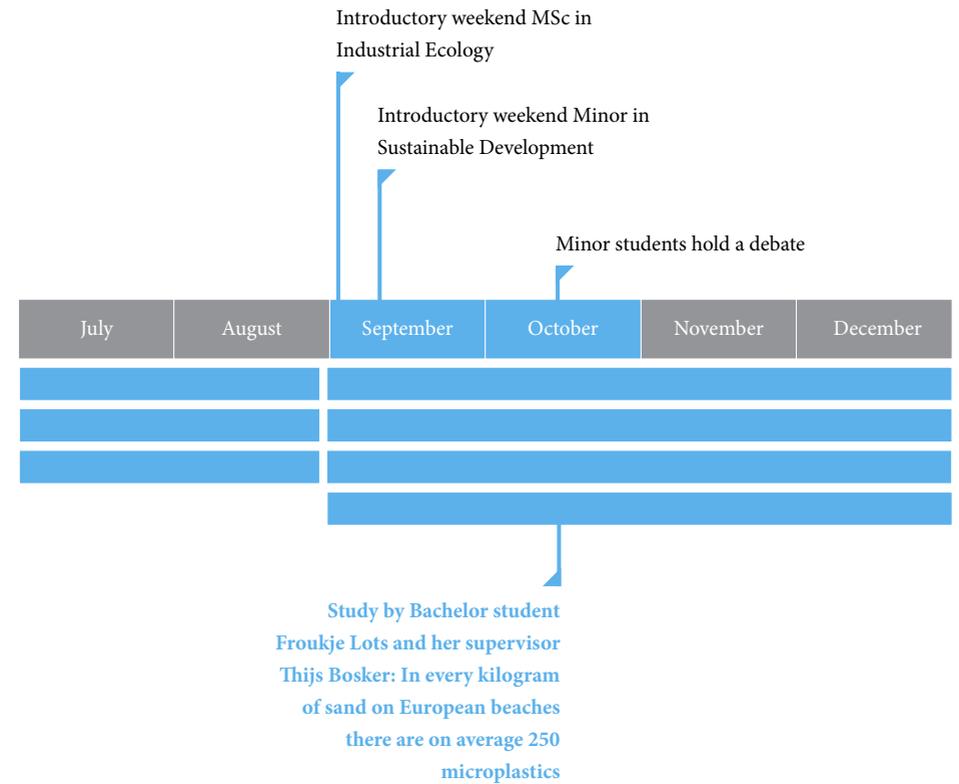
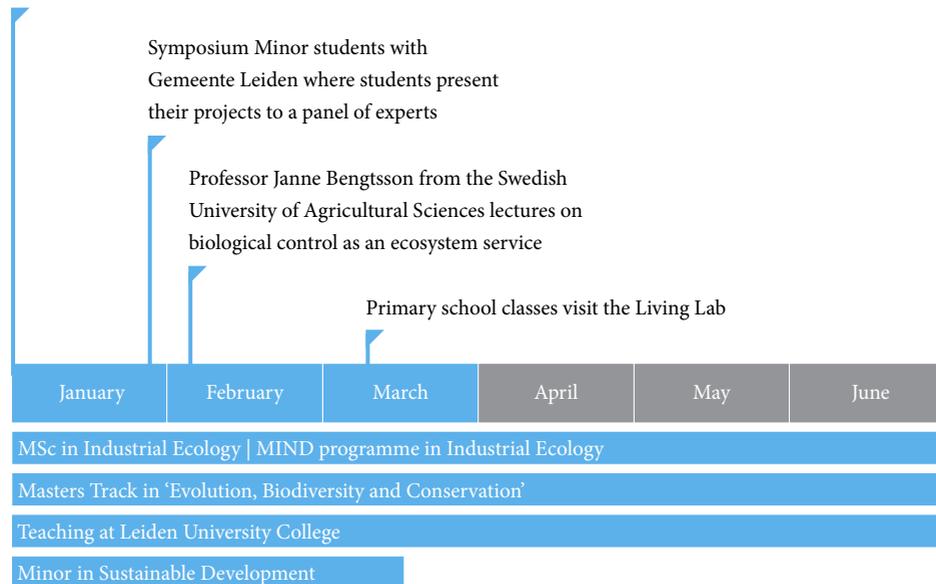
Read the article:
tinyurl.com/PaperMetalConstraints

“The research results encourage a fast transition towards renewable energy technologies without being too worried about not having enough metal resources available.”

Arjan de Koning, researcher at the department of Industrial Ecology.

Education 2017

Minor students work on real-life sustainability challenges in Leiden, Indonesia and The Philippines





Plastic between your toes

Bachelor student researches microplastic contamination in European beach sediment

The sand on European beaches may look pristine, but in every kilogram of sand there are on average 250 microplastics: fragments smaller than 5mm. These results are part of a study by Leiden researchers with the help of beachgoers throughout Europe.

Plastic is everywhere. This is in short the key outcome of a study by Bachelor student Froukje Lots and her supervisor Thijs Bosker. They found that every kilogram of sand on European beaches contained on average 250 fragments of microplastic. In some locations the number can be even higher, a place in Iceland had 700 microplastics per kilogram, and in Italy it was as high as 1,500 per kilogram. Bosker has already found relatively high levels in the Netherlands, with 500 fragments per kilo on the beach near to The Hague. The microplastics originate from larger plastic objects that slowly disintegrate. These findings are part of a larger-scale investigation of microplastics on European beaches. The researchers analysed a total of 23 locations in 13 different European countries. They published their findings in the journal *Marine Pollution Bulletin*. “Our research shows that these microplastics are

present on all beaches we sampled,” Bosker, Assistant Professor of Ecotoxicology, commented. “If you fill an espresso cup with sand, it will contain easily twenty-five pieces of plastic, with the number of fragments changing according to the location.”

Bosker is currently working on a follow-up study on the amounts of plastic on beaches along the Dutch coast and in the Caribbean region. As well as investigating the distribution of microplastics in the environment, his group is also studying how they might impact organisms.

Citizen science

In their research Lots and Bosker used citizen science to collect samples. Via their website and social media channels the public was invited to collect sand around Europe. Their request met with an enthusiastic response, from colleagues and friends, as well as from other beachgoers throughout Europe. Lots and Bosker also used the extensive international network of Leiden University College. As a result they were able to include many European beaches in their research.

Read the paper here:

tinyurl.com/PaperPlasticBeaches

“We are conducting experiments to find out if microplastics cause negative effects on plants and animals”

Thijs Bosker, Assistant Professor of Ecotoxicology



Area studies minor students

Minor students work on real-life sustainability challenges in Leiden, Indonesia and The Philippines



Students of the interdisciplinary minor in Sustainable Development learn to address sustainability challenges from a systems perspective. Every January, they can put what they have learned into practice in a choice of exciting and practical Area Studies. In 2017, the students advised Leiden municipality, studied biodiversity in Indonesia and researched the aftermath of cyclone Lawin in The Philippines.

Area study The Netherlands

Leiden Municipality has set itself several sustainability targets to become a much more sustainable city by 2030. To achieve these targets, the Municipality has launched 24 initiatives and 41 ideas. Six student groups investigated specific questions set by the Municipality related to these initiatives and ideas; for example, some of the groups investigated the opportunities for mitigating water problems, the potential for urban farming, and how a more efficient recycling system for electronic waste could be set up.

Area study Indonesia

In the tropical forests of Indonesia, the students are confronted with the high biodiversity and the degradation thereof. After a series of lectures at Universitas Indonesia, the students conduct a research project, while based at a field station in one of Java's nature reserves. The students worked on projects related to, for example, challenges imposed by habitat loss, wildlife trading, opportunities for sustainable harvest and the importance of biodiversity for water-related services for the population of Jakarta.

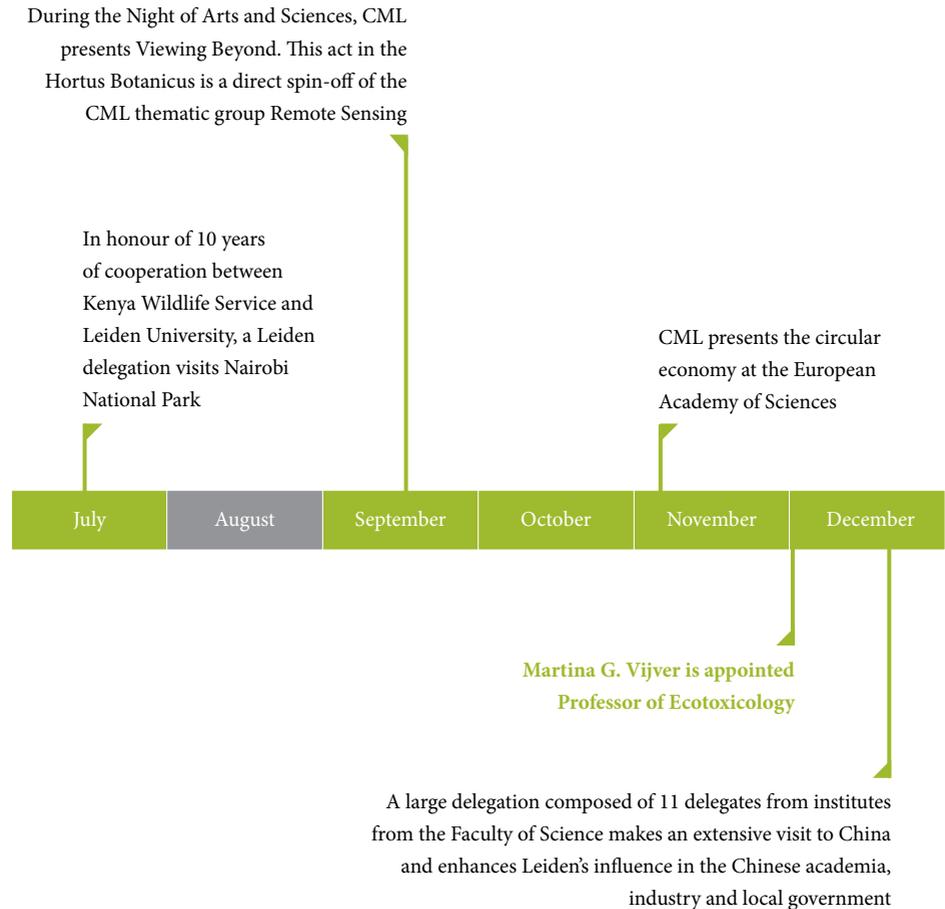
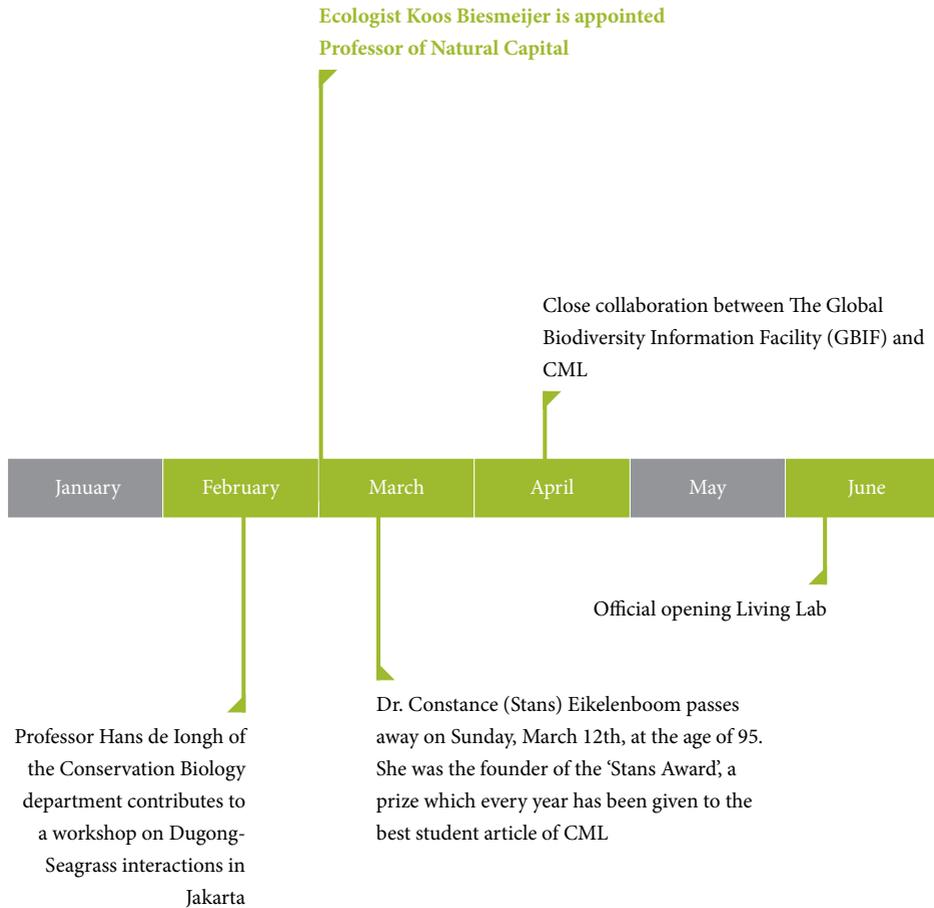
Area study The Philippines

The Philippine area study starts with students visiting several (inter)national organisations in Manila and Los Banos to learn about environmental issues related to sustainable water and water management in the Philippines. In collaboration with Isabela State University and the Mabuwaya Foundation, the students gain practical experience through researching questions surrounding the impacts of the large tropical cyclone Lawin that the country experienced just prior to the field course, and how the population responded to this emergency.

"I felt so happy and proud to have been part of the course and the Filipino culture!"

Jemima, student participating in area study The Philippines

Organisation 2017





Koos Biesmeijer appointed Professor of Natural Capital

He is combining his professorship with his position as Scientific Director at Naturalis

Ecologist Koos Biesmeijer is appointed Professor of Natural Capital at CML per 1 March 2017. Through this collaboration, Naturalis Biodiversity Center and Leiden University aim to boost the position of Leiden within the national debate on sustainability issues and the importance of natural processes therein.

CML and Naturalis Biodiversity Center – both located at the Bio Science Park Leiden – aim to broaden and intensify their current collaboration through common projects, PhD students and shared facilities. The institutes see Biesmeijer, Scientific Director at Naturalis, as the perfect candidate to fulfil this intention. ‘Biesmeijer’s work on drivers of pollinator change and on crop pollination perfectly matches and complements our research to understand and predict human impacts on ecosystems and biodiversity,’ CML Director Arnold Tukker writes. The Director of Naturalis Edwin van

Huis confirms this: ‘Professor Biesmeijer’s field is highly suitable for collaboration and will include the broader spectrum of biodiversity research. His position as Scientific Director at Naturalis will play an important role in this.’

Biography Koos Biesmeijer

Biesmeijer studied biology at Utrecht University and obtained a PhD summa cum laude on the behaviour and social organisation of bees in 1997. He worked as a researcher at the University of São Paulo (Brazil), Cornell University (United States) and the University of Leeds (United Kingdom), after which he started working at Naturalis Biodiversity Center in 2010. In 2013 he became Scientific Director at Naturalis. Between 2012 and 2017, he was Professor by special appointment of Functional Biodiversity at the University of Amsterdam. For his appointment at Leiden University, Biesmeijer will work one day a week at CML.

Read more about Koos Biesmeijer:
tinyurl.com/KoosBiesmeijer

“I believe that, as a scientist, one has the obligation to find ways to make knowledge useful for our society and to inform decision-makers about important issues. In my case, this is biodiversity.”

Koos Biesmeijer, Professor of Natural Capital and Scientific Director at Naturalis

Martina G. Vijver appointed Professor of Ecotoxicology

Gaining insights into chemical stressors to
assess and mitigate ecosystem threats

Environmental scientist Martina G. Vijver is appointed Professor of Ecotoxicology at the CML institute at Leiden University per December 2017. Vijver works on obtaining realistic predictions and measurements of how existing and emerging chemical stressors potentially affect our natural environment and the organisms living in them.

Gaining insights into the effects of chemical stressors is essential to provide the necessary tools to assess and mitigate ecosystem threats. While the basic idea is straightforward, attaining reliable estimates on the fate, the actual uptake and effects of chemicals on species and their overall effect on ecosystems has proven to be notoriously challenging. The ecotoxicology research line aims to predict the impact of environmental stressors across increasing environmental complexity and spatiotemporal scales.

Vijver's passion is to work on these innovative challenges in which some aspects are a must for her.

These are: field representative setting and accounting for dynamics is key, and the whole chain of fate and behaviour, uptake and elimination, and responses should be considered, preferably quantitative and integrative. Data collection is done following different approaches, ranging from lab-derived experiments to outdoor mesocosms, as well as in situ experiments in the field, monitoring data and secondary data analyses.

Biography Martina G. Vijver

After her PhD in 2005 at VU University Amsterdam, Vijver became Assistant Professor at Leiden University. She has more than 100 peer-reviewed publications to her name that are quoted worldwide. She has contributed to two different educational textbooks in the field of environmental sciences, and obtained a VENI, VIDI and several European research grants. In addition, she has received various prizes, including the World Cultural Council in 2017 for the dissemination of scientific research results. She is a co-founder of the Researchers in Science for Equality network, a platform for female scientists at the Faculty of Science.

“Our research outcomes can play a guiding role to achieve more sustainable and safer products and materials, benefitting the environment and human health.”

Martina G. Vijver, Professor of Ecotoxicology

See you next year?

We trust this annual report has given you an idea of our institute's activities and successes in 2017. For additional information, please visit our website: cml.leiden.edu or contact us on +31 (0)71 5277461 or by email at secretariaat@cml.leidenuniv.nl. We look forward to hearing from you.

We are proud of what we achieved last year and are excited about what the future will bring!

CML staff, researchers and students

Colophon

Compiled by Merel Segers
Sustainability Analysis & Communication.

Editorial team

Design & Writing: Merel Segers
Language Editor: Claire Taylor

Our thanks go to all the CML staff, researchers and students who contributed to this report:

Paul de Hoog, Ester van der Voet, Peter van Bodegom, Jeroen Guinée, Koos Biesmeijer, Reinout Heijungs, Thijs Bosker, Arjan de Koning, Willie Peijnenburg, and Martina G. Vijver.





**Universiteit
Leiden**
The Netherlands

